CORNELL
EXTENSION BULLETIN
1039

New York State
College of Agriculture

FARMSTEAD ENGINEERING for dairy farms

CONTENTS

Introduction 1

Farmstead Organization 2

Principles Of System Planning 7

Handling:

- Grain and Concentrates 8
- Hay 10
- Silage 12
- Bedding 13
- Manure 14
- Milk 16

System Planning Procedure 18

A Loose Housing System 21

A Stanchion Barn System 23

Comparison Of The Two Systems 24

ACKNOWLEDGMENTS

Illustrations through the courtesy of:

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Babson Brothers
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FARMSTEAD ENGINEERING FOR DAIRY FARMS

by

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Introduction

The need for improving production efficiency to increase net profit and to permit economic survival has forced the search for better, more efficient ways of performing the tremendous amount of labor involved in the operation of dairy farms.

Field operations have been streamlined and mechanized, but improvement in chore work performance has not kept pace. Today forage production without mechanized equipment is unthinkable, yet when the material which was mechanically handled in the field arrives at the farmstead, storage in inefficient types of structures and hand operations for handling it into and out of storage are considered acceptable methods. Even today, on some farms, much chore work is being done basically as it was 75 years ago.

The advances in increasing field work productivity have been dramatic. The increase in the efficiency of performing farmstead work - the routine operations performed in and around the dairy barn - has been much less substantial. Still more than 80 per cent of the total work load on dairy farms is concentrated at the farmstead. On some farms, where feed production has been curtailed or eliminated, almost all of the labor required to operate the farm is chore work.

The importance of farmstead labor efficiency is sometimes obscured by the fact that the labor is distributed throughout the year and materials are usually handled in small batches. Studies of farmstead labor, however, show conclusively that great improvements can be made. They also demonstrate that the most marked improvements come when the farm operator acts as a planner and manager and not primarily as a laborer.

The figures below, based on a study of 244 dairy farms, emphasize the tremendous quantity of materials handled in even modest dairy farm operations. It also shows the extreme variation in productivity between manual handling and more efficient methods. In this study the average herd size was 28 milking cows and 21 head of non-producers.

		Man Hours Per Year	
	Tons Per Year	*Manual Handling*	*Efficient Handling*
Hay	122	338	88
Silage	226	450	70
Bedding	37	100	77
Manure	535	738	75
Ground Feed & Concentrate	85	230	95
TOTALS	1005	1856 (232 eight-hour days)	405 (81 eight-hour days)

The figures represent the averages of groups of farms doing various operations manually or by more efficient methods. The term "efficient methods" does not necessarily mean mechanization or automatic equipment. In many instances it does, but on almost any farm there are many things that can be done to ease the materials handling operation without major investments. They may involve modification of work pattern, form of materials, arrangement of farmstead, management practices, etc.

Farmstead Organization

Operating efficiency of the modern farmstead depends on the type of buildings used, their internal and external arrangements, and the wise selection and use of the necessary mechanical, electrical and structural equipment.

Too often farmstead organization is considered a static thing with improvement coming only after heavy spending. This is not necessarily the case. Careful planning and a clear-cut goal can result in good farmstead organization, even though major improvements are made one at a time. This doesn't mean planning farmstead improvements one at a time. On the contrary, it means that the reorganization plan is *not* made piecemeal but is simply put into effect piecemeal. There is a great difference.

The job of reorganizing a farmstead frequently becomes complex and confusing because it involves the solution of several problems at once rather than one at a time. This complex job can be simplified, however, by breaking it down into the following three phases:

(1) Inventory existing facilities - both buildings and equipment - in the light of present requirements.

(2) Make decisions affecting future operations and needs.

(3) Develop a plan. Set up a "first-things-first" list of improvements that will contribute to the total need as quickly and as economically as possible.

Take an over-all look at existing facilities. Analyze the present set-up to see if it helps do an effective job with chores and materials handling. All buildings and equipment should work together as an efficient unit and they should be used to the fullest extent.

"Good" buildings are constructed so that mechanical equipment can be maneuvered for hauling in feed and bedding and removing manure. Lots, too, should be easy to get into and paved for easier cleaning. The tractor-mounted loader is one of the greatest labor-savers on the farm, but its effectiveness is greatly reduced unless it is easy to use.

Grain, forage and bedding should be stored so that they can be used with a minimum of handling and moving. On some farms, feed is handled three or four times and moved long distances in order to get it from storage to the animals.

With good planning, the distance feed is moved and the number of times it is handled can be reduced. In some cases it need not be handled at all by the operator, but can be moved by mechanical means, by gravity, or be self-fed.

In looking over the entire operation, try to determine where the most time and effort are spent with the least accomplishment. Perhaps the number and length of trips can be reduced. For example: store grain, hay and silage near where it is fed; arrange feeding devices to eliminate an empty cart on return trips; simplify or eliminate hand operations by mechanizing with conveyors, elevators, feed carts and so forth.

Plan Present and Future Needs. It is becoming more apparent that any steps taken toward improvement must be decided on the basis of efficiency and flexibility. Labor efficiency will pay now and in the future. Flexible buildings and equipment will permit changes with future production and marketing demands and new farming methods.

One of the common mistakes in farmstead organization is the assumption that more and better labor-saving *equipment* is the whole answer. Even though additional equpiment will probably improve efficiency, a great deal of spade work on building and lot arrangement should precede the selection and installation of equipment. *Good arrangement has no operating cost* and will almost always reduce the cost of installing and operating essential equipment.

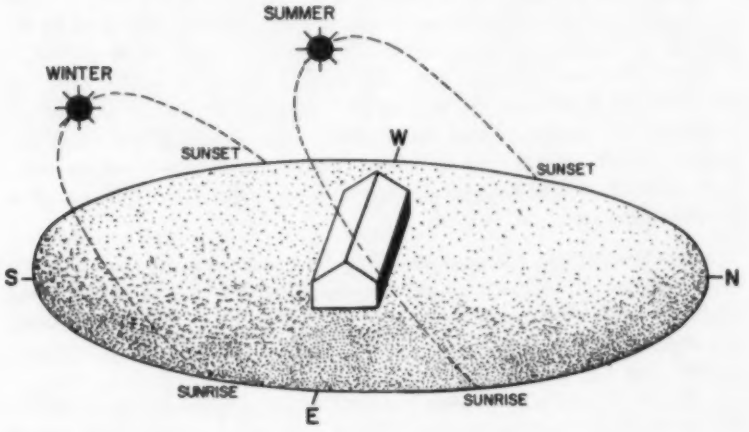
Flexible buildings not only provide adequate shelter for livestock, but also permit the maximum use of mechanical equipment in moving feed and bedding into the building and moving waste products out.

Frequently the external arrangement of buildings is as important as the type of buildings used. Buildings serve several functions by location alone. Among these are windbreaks to open lots, locations which include arrangements for easy cleaning, space for maneuvering machinery, maximum exposure to sunlight, proper drainage and accessibility for bulk tank trucks and other large service vehicles.

Climate, especially the direction of prevailing winds and the path of the sun, will influence decisions. Take these factors into account and work out an arrangement that will make best use of the good features and help to overcome the poor ones.

Such problems as slope of the land and drainage will often come in for serious consideration. Slope and the drainage pattern can frequently be altered at reasonable cost, but if it isn't feasible to do this, consider these factors in the same category as weather conditions. It may even be necessary to choose another site where slope and drainage are more suited to the layout.

Do not consider farm roads, building openings, and similar things to be permanent features. Most items of this nature can be easily changed.



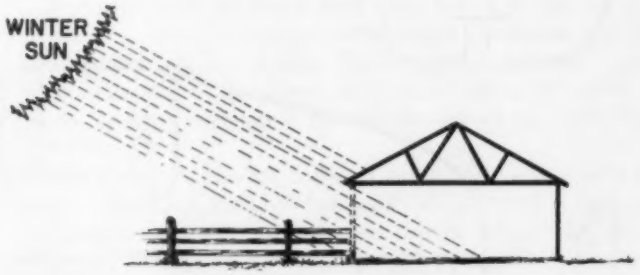
The wintertime path of the sun is low in the sky, while its summertime path is high. Properly oriented buildings allow better use of the warming and drying effect of the sun's heat during the winter, while excluding most of the hot, direct rays in the summer.

An easy way of building up a basic plan is to use circles or ovals to represent the various elements which make up the farmstead. An example of a "doodle" drawing is shown on page 6. The appearance of the drawing is not important - the relationship of the various parts is the important thing.

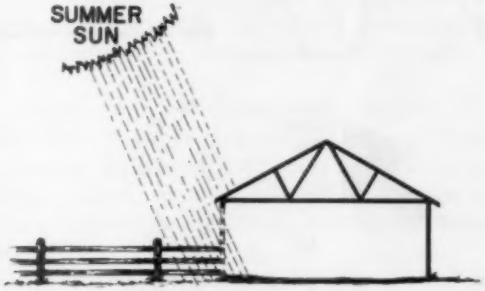
This "circle" planning procedure works well for reorganization plans as well as for new ones. For reorganization, work out a more or less ideal ar-

rangement and see how it fits in with existing facilities. Sometimes even relatively minor changes will fit the whole thing together. But don't let poorly-located old buildings of questionable value influence the final plan too much.

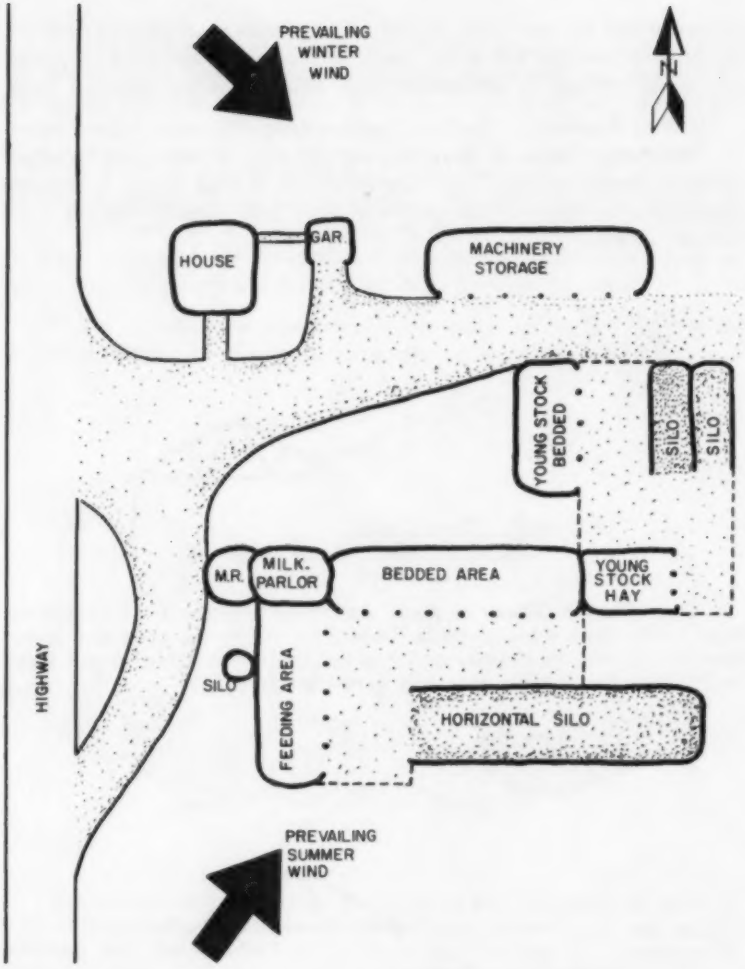
Make a Priority List. The list of improvements to be made is the last step. The first changes should be those that will add most to making the farmstead operation efficient and easy. But, above all, be sure to make the list so that each improvement or group of improvements made will dovetail with the steps that are to follow.



Open front buildings or those with large window areas should be faced to the south when possible. During the winter the sun's rays penetrate deeply into the shelter, warming and drying the bedding and helping to keep the feeding area and paved lot dry.



In summer the hot rays penetrate only a short distance into the shelter. Wide overhangs, especially the awning type that can be removed or folded up during the winter, give added summertime protection.



Open-front buildings and livestock yards should be arranged so that animals are protected from winter winds and exposed to cool summer breezes. In winter, protect against the prevailing winds from the northwest. In summer, take advantage of southwesterly breezes. Locate livestock yards and silos so that summer breezes do not carry odors towards the residence. Ideally these areas should be located northeast of the dwelling. Avoid a southwest location if at all possible. This "doodle" drawing shows the same arrangement solution as the more finished drawing on page 22.

Principles of System Planning

An objective outlook is necessary for making sound decisions. One of the most difficult, yet most vital parts of this outlook is a willingness to change. Improvement invariably requires change, so consider modifications in crop production and harvesting methods. Housing systems, management and feeding practices should not be thought of as fixed until these items are carefully studied and the alternatives weighed.

After developing an objective outlook, plan to:

1. *Eliminate unnecessary operations* - Because something has been done for years doesn't mean there is a good reason for it or that the original reason is still valid. An example is the manual distribution and packing of silage in a silo as it is filled. This operation is generally considered to be unnecessary. Another example is the stockpiling of manure in the winter. In most areas this is rendered unnecessary by modern tractors and spreaders.
2. *Reduce distances* - Plan the farmstead and building arrangement so that distances are short. Feed and bedding should be stored (either laterally or vertically) next to the area of use to minimize the moving operation. Too many farmers, for example, move grain one, two or three hundred feet in buckets, bags, baskets or carts for each feeding.
3. *Use gravity whenever possible* - Dumping loads, dropping hay into a feeder from an elevated mow, spouting grain from storage to feeding points are examples of the use of gravity to reduce handling with a minimum of equipment.
4. *Use hands efficiently* - The human hand is an extremely versatile device but not particularly efficient as a power transmitting unit. It is much more effectively used in operating controls than forks, shovels, baskets, etc.
5. *Let livestock help* - Self-Feeding is an effective way of minimizing feeding labor. If self feeding won't fit into your feeding program, at least consider the possibility of letting the livestock go to the feed to eliminate a moving operation. The milking room system is an example of letting livestock do the moving and reducing distances of operator travel.
6. *Plan sequence of operations* - Arrange facilities so that the various chore operations can be performed in sequence as you move about the area without bypassing and back-tracking.
7. *Handle feed in bulk* - This facilitates continuous flow, mechanical handling, spouting, etc. Bales, bags, buckets and baskets represent small batch handling and are symbols of inefficiency and drudgery.
8. *Mechanize major operations* - After working the first seven ideas into a

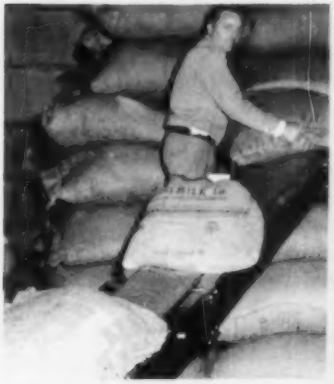
system there will be many operations remaining for which machines are the only alternative for manual labor. Silo unloaders, mechanical feeders, barn cleaners, automatic grinders, etc., offer solutions to major time and effort-consuming handling problems.

9. *Select versatile equipment* - When possible choose equipment than can do more than one operation. For example, some elevators will handle bales, chopped hay, ear corn and small grains and in long lengths can be used for filling silos. They require much less power than a blower of similar capacity and keep the equipment inventory down. Some unloading wagons are equally versatile. The front end loader on a tractor is another example of an item of many uses.

Grain and Concentrate Handling

Bulk handling of grain, generally accepted by processors and suppliers, is a basic part of increasing efficiency and reducing cost and is not a passing fancy or fad. It is as valid on the farm as it is at the mill.

Bags mean batch handling and this involves manual handling at several points even when all possible mechanization is used. Each pound of grain is (1) manually placed on the conveyor or elevator, (2) moved from conveyor to stockpile, (3) carried to the feeding point, (4) dumped into feed cart or other feed receiver and (5) generally fed with a measuring scoop. Some of these operations can be eliminated or made relatively easy to perform in well-arranged systems, but manual bag handling can't be eliminated.



Here are some things which should be considered if bagged grain must be used: (1) Dumping bags into a bulk bin from the delivery truck, (2) locating the bulk bin or bag stockpile next to or above the feeding area, (3) using a gravity spout to load feed carts, (4) using gravity spouts to grain meters in milking parlors. These ideas will not eliminate manual handling of

every pound of bagged grain as it is received on the farm and fed in stanchion barns, but without these ideas in the system, all grain may be handled manually as many as five times.

Bulk grain handling, on the other hand, provides for the elimination of manual handling in loose housing systems and reduces it to only the feeding operation in stanchion barns. The delivery truck can place it in an overhead bin or into a ground level bin (perhaps outside the barn). An inexpensive auger can deliver feed to a cart from a ground-level bin, or a gravity spout can deliver it to a cart from an overhead bin. With relatively little investment this leaves only feeding to be performed manually.

In loose housing systems, bulk grain should be received and stored over the milking parlor. An auger or chain conveyor will maintain a supply in each down spout for the meters at each milking stall. No manual handling need be involved and control of each cow's feeding is maintained. Several makes of meters are available which permit sufficient accuracy of control of the amount of grain fed individual cows.

Grain is probably handled more efficiently on farms than most other materials. Bulk handling and delivery by suppliers has encouraged improvements in on-the-farm handling. Where this is not the case, however, some planning, revision of facilities and modest investments can extend to the farm operation the advantages which bulk handling offers the supplier.

Hay Handling

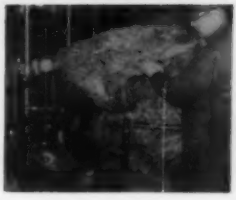
Baled or chopped hay? How much hay compared to silage? These are basic questions to be answered by each operator and the answers can make considerable difference in the ultimate labor efficiency of the system.

Baled hay, like bagged grain, does not permit elimination of manual handling. Most current baled hay handling systems involve manual handling of every bale in: (1) loading onto vehicle, (2) piling on load, (3) placement on elevator, (4) distributing in mow, (5) stacking in mow, (6) removal from mow, and (7) breaking and distributing in feeding. Tonnages are great and manual handling operations are numerous.

Several things can be done to minimize labor in baled hay handling: (1) loading directly from baler or using a mechanical loader; (2) using a mow distributor (as shown below); (3) allowing the bales to fall and remain in a randomized pile (this requires about 20 per cent more space than when stacked); (4) gravity filling of feeding racks or wagons; (5) fence-line feeding next to ground-level storage.

At best, with most balers, the manual operations can be reduced only to: (1) piling on vehicle, (2) placement on elevator or ground level stack, (3) moving from storage to feeder. Balers with bale throwing attachments and unloading wagons eliminate items (1) and (2).

In long stanchion barns, along long feed bunks, or where bales are stored some distance from the feeding area, bales can be hauled and distributed with trucks or wagons to reduce effort, but this still involves three manual handlings in removal from storage, piling on vehicle and unloading. Baling hay has some advantages, but efficiency in handling is not one of them.



Chopped hay allows complete mechanization of harvesting and storage operations, permitting the use of augers, conveyors, blowers and gravity in handling. In loose housing systems it can be self-fed from storage, mechanically fed, bunk fed from side-discharge unloading vehicles, or fed from self-feeding racks. With ground-level storage, no manual handling is needed, and with elevated storage the only manual handling is pushing the hay from storage to an opening in the floor or wall.

For mechanical distribution of feed to mature cows, each should have about 30 inches of bunk access. In self feeding, where they have continuous access to the hay, 9 to 12 inches is needed per animal.

In stanchion barns, chopped hay normally involves two manual operations: (1) removal from mow and (2) distribution in manger. If the cows are faced in and the distance between stanchion rows is about 12 feet, feeding may be done with a side-discharge unloading vehicle. (The same one used in harvesting). This vehicle may be loaded with a tractor scoop from ground-level storage or by gravity from overhead storage.

Chopped hay should be long (between 4 and 8 inch cut). This can be done with the same field chopper used for silage. Using the same vehicles and elevator or blower here eliminates the need for the two sets of machinery which would be required for baled hay and silage. This saving can be used at the farmstead for a more completely mechanized system.

Dustiness of chopped hay may be a problem in stanchion barns, but is of little consequence in loose housing systems.

Silage Handling

Whether grass, legume or corn silage is involved makes little difference in the systems and equipment for handling it. What does makes a big difference is whether vertical or horizontal silos are used and whether cattle are housed in loose housing or stanchion barns. In any case, it's possible to completely mechanize silage handling.

Unloading wagons or dump trucks and an elevator or blower allow mechanical harvesting and placement in storage. Side unloading wagons adapt also to mechanical feeding whereas back unloading units don't. Elevators have many uses besides silo filling (bales, grain, chopped hay, etc.), while blowers are more limited. Blowers need several times as much power as elevators for the same capacity, which usually means another tractor is needed for harvesting.

Distribution of silage in either vertical or horizontal silos can be done mechanically as they are filled. In vertical silos, distribution is important and should be directed around the sides and allowed to fall toward the center down an inverse cone. This is done with the unit shown. Compaction is no problem in vertical silos and tramping is useless except at the very top. In horizontal silos, both distribution and compaction (both can be done mechanically with a tractor and scraper blade as shown) are important.

Removing silage from storage requires much more time, effort and personal danger than silo filling, and yet this is a manual operation on many farms. It need not be. Consider letting either machinery or livestock do this chore. Self feeding is easily arranged and controlled with horizontal silos in loose housing systems. In vertical silos it is not as common nor as easily set up, but it is being done in a few installations. Cattle have plenty of time.

Mechanical silage removal and feeding fits either loose or stanchion housing. The mechanical silo unloader for vertical silos and the front end tractor loader for horizontal ones can deliver the silage to the mechanical feeder or to the feeding wagon. The side unloading wagon, which has many other uses, will deliver and meter it into indoor mangers or outdoor feed bunks. Feed bunks should be used as the fence-line of the feed lot to eliminate driving through the lot for feeding.

Mechanical feeders are practical when cattle are free to go to them, but they appear impractical at present for installation in stanchion barns. The auger feeder or the single endless chain types which permit feeding from both sides reduce investment and present little problem in quantity control. They are allowed to run until the silo unloader has delivered a sufficient quantity. With other types which can make only one pass along the bunk before discharging silage at the far end, there is a serious problem of controlling quantity. Direct delivery from the silo unloader will not work with this latter type.

Fence-line feeding from a paved strip is another method. Here cattle eat through a special fence, with silage distributed by a mechanical wagon or directly from a near-by horizontal silo with a front end loader on a tractor.

Serious thought should be given to location when building new silos. There is considerable merit in having them away from the barn for easy equipment access and having them close to mechanical feeders. They are also less likely to interfere with future expansion. In any event, silos should not be in the barn lot or too close to the residence.

Bedding Handling

Of all the materials used on a dairy farm, bedding is perhaps the least adaptable to complete mechanical handling. The nature of operations involving bedding and the quantities involved make mechanization impractical in stan-

chion barns, but there are several things which can be done to save time and effort. Bedding, in large or small quantities, should be stored close to or over the stable. Shavings, sawdust, or other fine materials can be stored in hopper bins (filled with an elevator) for gravity filling of carts below.

For stanchion systems, baled or chopped straw should also be stored close to the use area. Baled straw, like baled hay, requires several manual handlings, even in the most mechanized systems. In addition, the bales must be broken up and the slices shaken out for effective use as bedding. If straw is to be used there are advantages to chopping it.

In loose housing systems, it is practical to store bedding either above the loafing area or in an enclosure at its side or end. If stored above, it can be loaded by gravity (except for bales) into a spreader or an unloading wagon for general distribution. Some additional hand spreading may be necessary. Shavings or sawdust can also be delivered to and stored in a bin at ground level in the loafing area. If possible, the bin should be located for filling from the door yard side and have doors on the inside large enough for removal of bedding with a tractor scoop. The tractor scoop may be used directly for general distribution.

Manure Handling

Manure represents the greatest tonnage of all materials handled on dairy farms. Fortunately, it is relatively easily mechanized although it is only semi-mechanized, (or not even that) on many farms. In many stanchion barns manure is loaded from the gutter into wheel-barrows, monorail carriers or spreaders driven through the stable. This eliminates manual removal from the barn but still requires that every pound of manure be lifted and loaded with fork or shovel. Many types and makes of mechanical cleaners have been developed and are generally available. Most of them provide for elevation for discharge into the spreader. This feature eliminates a separate loading operation

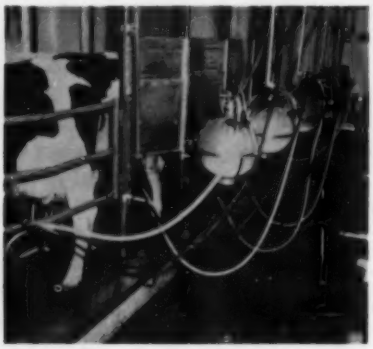
and should be incorporated into any mechanical system. With modern tractors and spreaders there are very few days in the year when manure cannot be spread. Box stalls and calf pens are less easily mechanized, but manual effort can be minimized by running the gutter cleaner through or past them and covering it with removable plates. Manure is then scraped into the opened gutter for relatively easy removal.

Because of the size of manure removal and milking operations, many double line stanchion barns are arranged so that cows face out. Equipment development in recent years, however, has made it quite easy to mechanize the operations on that end of the cow and has shifted the problem to the manger end; so it's better, when planning a stanchion barn, to face the cows towards a center feed aisle. This does not complicate the use of new equipment for manure removal and milk handling but does provide for mechanization of feeding.

In loose housing the feeding area and paved lot have to be scraped clean frequently, while the loafing area is cleaned less often. Both of these operations can be done with power equipment at little added expense, since tractor, spreader and front end loader are standard items on most farms. Perhaps the only "extra" investment needed for complete mechanization of manure handling for loose housing is a scraper blade attachment for the loader. This blade can also be used for plowing snow and leveling silage in horizontal silos.

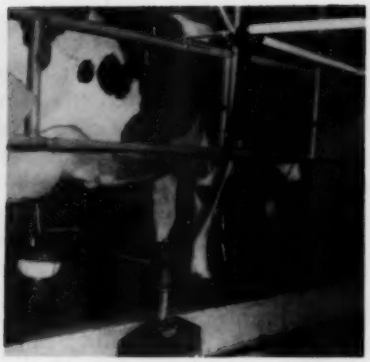
Milk Handling

Milking is generally done mechanically so little has to be said about the methods and benefits of this system. The following illustrations show recent milking progress and the other developments in barn design, lighting, sanitation, etc. which have accompanied it.



Still, little progress has been made on many farms in the handling procedures between the milker pail and the milk cooler. In large and often poorly-organized stanchion barns, milk moving is an arduous, time-consuming operation. Pails are outmoded and inefficient transporting units and cans are rapidly becoming so.

Bulk cooling and bulk handling, promoted and brought into being largely by dairy plants, are now generally accepted. Dairy farms have converted to bulk cooling and holding tanks, representing substantial investments, but these tanks as such are of little advantage to the producer except to preserve his market outlet. To get all of the advantages of bulk handling and real operational benefits from this investment, the system must be completed. This means the addition of a pipeline.



Pipelines for moving milk from the milker to the cooler are generally available and are demonstrating greater efficiency and sanitation for their users. The development of "in place" cleaning procedures has eliminated their major operational drawback. In stanchion barns the investment required for the pipeline is substantial and may be difficult to justify for smaller operations or where labor is plentiful and inflexible. A very practical compromise from the cost standpoint is the use of a "dumping station" and portable plastic pipeline. The dumping station is moved as milking progresses down through a stanchion barn. Like "permanent" pipelines, this system requires no auxiliary pump if used with a vacuum tank; otherwise, a sanitary pump is needed to move the milk through the line. Either a vacuum or a pump system is satisfactory, the vacuum tank offering no advantage unless a pipeline is used.

In some cases, the use of a milking parlor in conjunction with a stanchion barn may be less expensive than a pipeline. This alternative offers the further advantages of easier milking and more efficient grain feeding.

To reduce travel distance for moving milking equipment to a minimum in milking parlor installations, the milk room should be located adjacent. This also permits a very short pipeline and greatly reduces the cost of a complete bulk handling system. The vacuum tank system eliminates the sanitary pump and reduces the cost of a total system to the range of the semi-complete dumping station system in a stanchion barn.

How to collect, inspect and weigh the production of individual cows when using pipelines has bothered some producers who were considering them, but this is now possible in either stanchion barn or loose housing pipeline systems. However, it does involve added operational effort.

System Planning Procedure

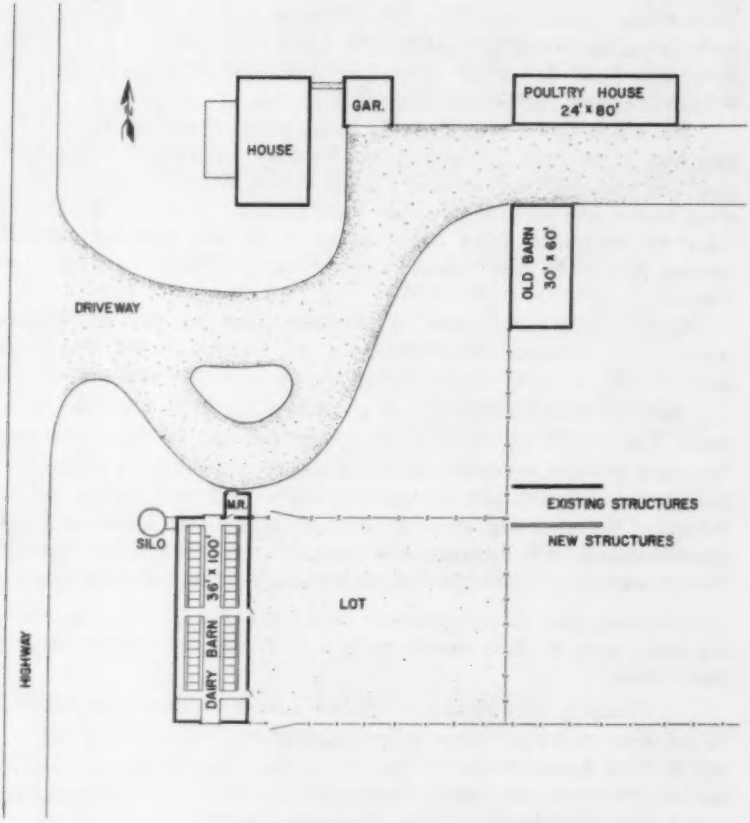
Previous sections have presented the case for a well planned and coordinated system, principles of efficient materials handling and practical methods for performing various operations. These are sound and highly desirable factors to consider and work into a new, revised or expanded system. Unless one starts with a clear area and develops an all new farmstead, however, there are limitations and problems caused by the practical necessity for using what already exists as much as possible. In such cases, care and judgement must be exercised, so that saving an old building or failure to do necessary grading doesn't restrict the efficient performance of a system representing a large investment.

When changes or additions are anticipated, it's time to review *all* facilities, practices and methods. No "as is" condition should be continued by default. They may well be continued, but this should happen only after objective consideration of alternatives indicates they are the most effective or practical.

As an example of the procedure for planning the facilities for an expanded operation, a typical case is analyzed and alternate solutions developed on the following pages. The procedure involves the three steps indicated on page 2. The decisions are based upon specific assumptions and conditions. In many cases, different conditions or different personal preferences might well result in different decisions.

This assumed operation handles 38 cows and raises its own replacements. The 120 acre farm is operated by its owner and a full-time hired man. A poultry operation has been discontinued, but the laying house remains. The gambrel roof barn holds 140 tons of baled hay above the stable. All buildings are in good condition except for an old barn which needs extensive repairs. More land for forage production and pasture is available near-by.

Problems causing current review of operation include pressure to go to bulk milk handling, only fair income for owner, and a son graduating from high school who is interested in dairying. They have seen and read about operations handling *40 cows per man* but with substantial investment for sav-



EXISTING FARMSTEAD

ing labor. What would it take for them to do this? Could father and son operate on this scale without hired labor, at least until the father wants to retire? They can, if they plan and procede with that in mind.

Inventory of Existing Facilities. The buildings are arranged to the south and east of the house so that west, southwest and northeast winds are no problem. The land across the road is not theirs, a hill drops off sharply north of the house, and there is a slight slope away from the south end of the barn. New buildings must be to the east, within the existing farmstead or else some

filling and grading must be done. The dairy barn, at grade level at both ends, is in good condition. The old barn needs a new foundation and a new roof, if it is to be saved. The poultry house is not being used, but could be converted to a machine shed by removing the south wall.

The silo is almost new. The milk house, poorly located at the end of a long barn, is too small. The yard is clear, level and well drained to the north, south and west. Machinery includes two-unit milker, can cooler, baler, chopper, silage blower, bale elevator, unloading wagon, manure spreader and a manure loader on the tractor. Baled hay is loaded in the field, unloaded onto the elevator, piled in the mow, removed from the mow, distributed, and fed — all manually.

Grass silage is loaded, unloaded and placed in the silo with a minimum of manual effort. Different sets of machinery are involved for hay and silage. Removal and feeding of silage is done manually with the use of a silage cart.

Shavings, used for bedding, are stored in a bin at the south end of the stable. They are loaded manually into a hand cart and distributed manually. Manure is removed by manual loading of a litter carrier on a monorail track and discharged directly into the spreader. Grain is delivered in bags, piled at the end of the stable and moved to point of use by a cart. Milk is carried to the milkroom in pails. It is easy to see how two men spend their time in this present operation. This is, however, not an uncommon type of operation.

Decisions about future operations: Before beginning to plan a system for the future, many decisions must be made. Some of the more important ones are listed below.

1. Change to loose housing or continue stanchion barn or a combination.
2. Ratio of hay and silage in feeding program.
3. Chop hay or continue baling.
4. Pasture or green feeding in summer.
5. Vertical or horizontal silos for increased capacity.
6. Elevated or ground level hay storage.
7. Bulk handling of grain (assuming it is bought this way).
8. Bulk handling of milk.
9. Many other smaller decisions.

Factors involved in making decisions:

1. Resulting labor efficiency.
2. Investment required.
3. Effects on management practices.
4. Flexibility of system - for modification or expansion.
5. Efficient and perhaps multiple use of equipment.
6. Adaptability to existing facilities.
7. Probable added costs vs. added returns.

Developing the plan: The decisions listed are related and cannot be made independently of each other. Neither can they be made without reference to a specific plan, so it becomes a matter of considering various combinations of alternatives. Perhaps the most basic decision is the one of loose housing or stanchion barn. It must be made even before a tentative plan can be formulated for fittting alternatives to the other decisions.

Many personal, financial, management and engineering questions enter into consideration of the housing method. The primary features of each method are:

Loose Housing

1. Lower-cost construction
2. Animals do the walking
3. Adapts to mechanization
4. Adapts to self feeding
5. Is flexible in scale

Stanchion Barn

1. Makes use of existing facilities by expansion and some minor modifications.
2. Closer control and observation
3. Individual roughage feeding
4. Less exposure to severe weather

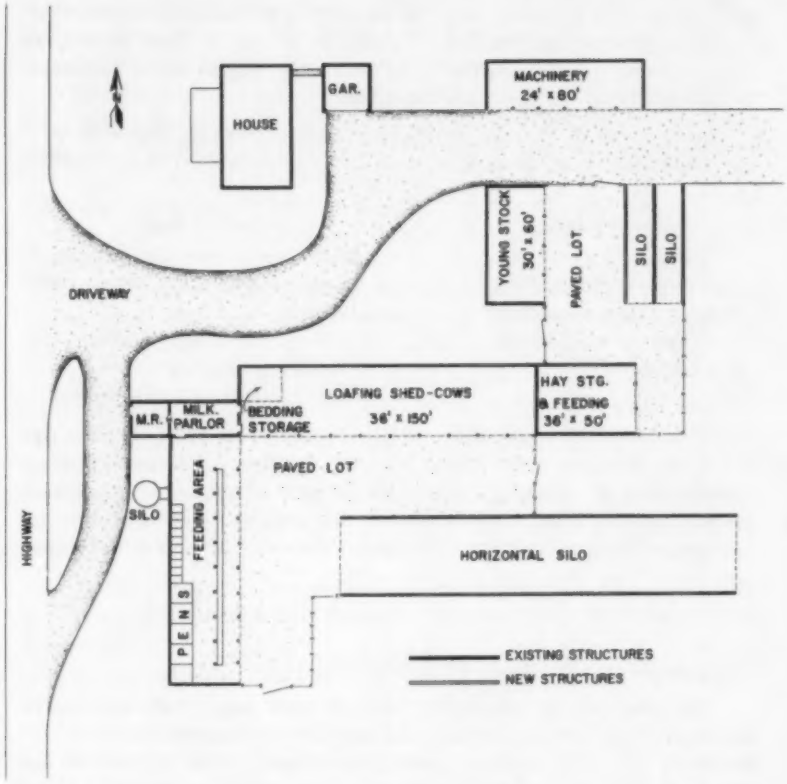
This example, like most operations, lends itself to expansion in either type of housing. Assuming either system, the other decisions can be considered and layouts developed accordingly. Examples of both stanchion barn and loose housing systems are offered as solutions to this example. There could be many variations of these systems, but it is impractical to attempt to describe them all here.

A Loose Housing System

This plan calls for construction of a 36' x 36' single story extension on the north end of the barn with a milk room on its northwest corner. It also includes a 36' x 200' building (perhaps pole framed) open to the south and east for loafing area and hay storage for young stock. The horizontal silo is located for self feeding of both cows and young stock. The old barn is repaired and opened to the east for young stock. This is possible because there is no ceiling to limit manure build up and tractor scoop cleaning. The old, single-story poultry house does have a height limit. For this reason, and because of its location and shape, it is better suited for machinery storage.

For several reasons, the existing dairy barn is best suited for a feeding area: the hay storage can continue to be used; it has too low a ceiling for a loafing area; the vertical silo is located adjacent to it.

By cornering the new buildings together, a continuous wind break is provided to the lot and the buildings open to the south and east. Cows enter and leave the milking area under cover. Easy access is provided to all critical areas



FARMSTEAD REORGANIZED FOR LOOSE HOUSING

for men, trucks and machinery.

Hay handling is minimized by using chopped hay. The same chopper used for silage can be used to chop hay (6 inches long) and the same unloading wagons and blower will get it into storage without manual handling - if a mechanical distributor is installed. The dust of chopped hay is no serious problem in loose housing. Chopped hay also lends itself to self feeding, which is not practical here because (1) the storage is elevated and (2) it was decided to leave the existing hay capacity as is and limit hay consumption and go to

heavier silage feeding. Some additional hay storage is provided for young stock. The only manual hay handling is putting it down chutes onto the mechanical feeder, which can be done at any point along the endless chain and flight feeder. Mechanical feeding would be very difficult with baled hay.

Manual handling of silage from storage is completely eliminated, through (1) self feeding, (2) an unloader in the vertical silo, and (3) an inexpensive portable conveyor to deliver silage from the silo chute to the mechanical feeder. The silo and mechanical feeding system fit well into a zero pasture program for summer feeding. For eighty cows, the mechanical feeder must be 100 feet long, with cattle feeding from both sides. Passageways must be provided at each end; so, it is necessary to extend the barn.

Manure is easily removed with tractor equipment from all areas except the maternity and calf pens. These could be provided with removable partitions for access with a tractor, although it might be more practical to simply hand pitch the manure through the doors to the feeding area where a tractor can get to it.

Shavings or other bedding can be delivered to the dooryard side of the storage bin and can then be removed from the loafing area side with a tractor scoop and deposited at various places for a minimum of hand spreading.

Grain is to be stored above the milking area in a bulk bin. A mechanical distributor (poultry feeder type) will keep a supply in gravity spouts to meters at each milking stall, providing complete mechanization of bulk grain handling.

Milking and milk handling labor is minimized with an eight stall milking parlor with a very short pipeline to the bulk tank. The milking area and milk room are conveniently located for (1) bulk milk trucks, (2) bulk grain delivery, (3) personnel from the house, (4) caring for stock in pens, (5) controls for mechanical feeder and silo unloader.

A Stanchion Barn System

The plan shows a 100-foot extension on the south of the 100-foot barn. This requires some grading and fill to bring it to an appropriate grade, but it is justified when the alternatives are examined.(To extend the barn to the north would bring it too close to the house. To form an "L" or a "T" shaped barn complicates the mechanization, operation and management.) The old barn is repaired and used for loose housing of young stock. The young stock are self fed hay from a 30' x 40' storage open to the east.

Baled hay is to be continued for the milk cows, but the storage capacity will not be increased. Increased forage capacity is to come from silage plus chopped hay storage for young cattle. Baled hay will be removed from storage manually and fed manually, but distributed by means of a hand cart.

Bulk grain is delivered to a bulk bin on the west side of the barn, an auger delivering the grain to the grain cart. Feeding is manual, but handling is minimized.

The silo is not in the most desirable location. It might be removed and incorporated into a new silo group. Feeding is performed mechanically by driving through the barn (twice) with a side-discharging wagon. Additional silage capacity may be obtained by adding vertical or horizontal silos. In the latter case, young stock may self-feed. If vertical silos are added, the young stock can be fed at a fence-line bunk with the wagon. With horizontal silos, the wagon may be loaded with a tractor scoop for feeding cows. The silage handling operations can be mechanized if the cows face into a wide feed alley.

Bedding is to be delivered to a bin over the new addition. A hand cart is filled by gravity and distribution is necessarily manual.

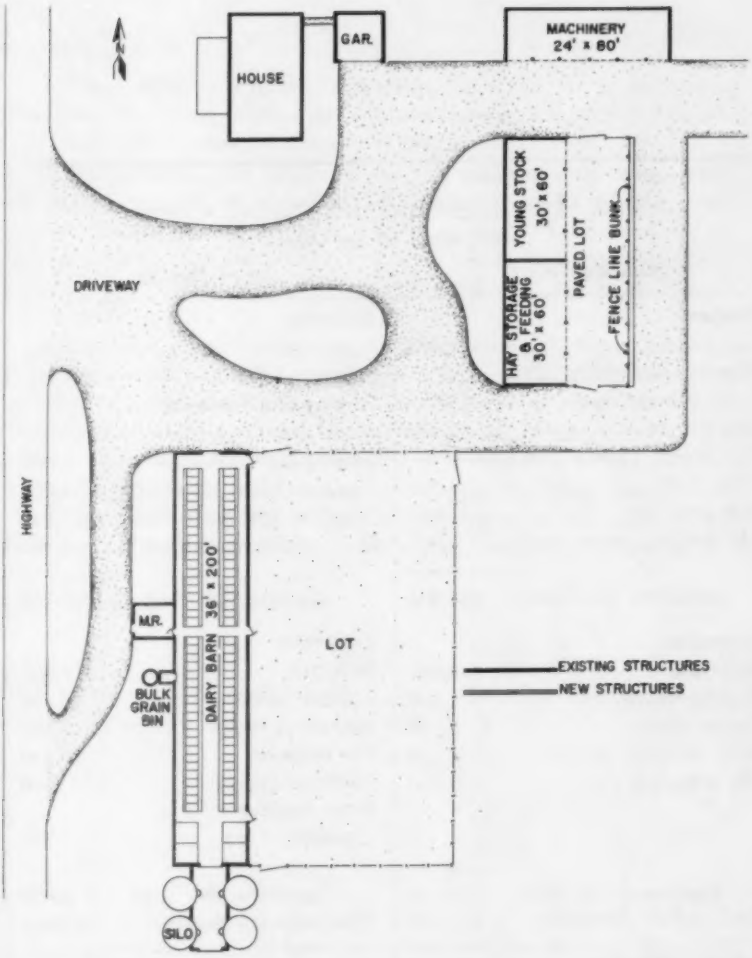
Barn cleaners mechanize manure removal from the cow barn. Young cattle areas are cleaned with a tractor. Barn cleaners discharging directly into a spreader eliminate stockpiling and extra operations.

Milk handling in a 200-foot barn is a problem. A new milkhouse is located in the center of the west side and a bulk tank installed. This location facilitaties bulk truck pick-up and reduces travel in milking. A pipeline solves the problem, but means a substantial investment. A partial solution which costs much less is a portable dumping station. In this installation, a portable dumping station with 100 feet of flexible line will eliminate the milk-carrying operation and will permit both men to operate milker units full-time while milking.

Comparison of the Two Systems

Both these systems represent large investments in capital but this is quite modest considering the more than doubled size of operation (to an 80 cow enterprise) and the resulting mechanization and operating efficiency. There are many details which can affect the total costs, but rough estimates for buildings and equipment would be $33,000 for the loose housing system and $41,000 for the stanchion barn system. It is assumed in these estimates that the operator will hire all of the construction, installation and remodeling work done.

The resulting systems are quite different. While the stanchion system may have several intangible advantages, it still leaves much manual materials handling and several other semi-mechanized operations. It is questionable whether it can be operated by two men (40 cows per man). The loose housing system involves nearly complete mechanization of materials handling. The only substantial manual operation is in throwing hay down onto the mechanical feeder. This system can be comfortably operated by two men. It is also more flexible in use of facilities for other enterprises or further expansion of the dairy herd.



FARMSTEAD REORGANIZED WITH EXPANDED STALL BARN

New Facilities and Estimated Costs

(over present 38-cow system)

Stanchion System		Loose Housing	
Structures		*Structures*	
Milk room	$ 2,000	Milk room	$ 2,000
Barn addition, 36' x 100', and silo enclosure	13,000	Milking parlor	3,900
Silos (4- 14' x 40')	10,000	Feeding area extension, one story	800
Hay storage (young stock), 30' x 40'	1,500	Loafing barn, 36' x 200'	8,000
Bulk grain bin	1,000	Horizontal silo, 36' x 200'	5,000
Old building remodeling	1,000	Paved lot (90 sq. ft./cow)	2,800
		Old building remodeling	2,500
Structures Sub Total	$28,500	Structures Sub Total	$25,000
Equipment		*Equipment*	
Bulk tank	$ 4,000	Bulk tank	$ 4,000
Feeding wagon	1,300	Pipeline (short)	1,000
Gutter cleaner	3,000	Mechanical feeder	1,500
Milk dumping station	1,200	Silo unloader	1,000
Silo unloaders (2)	3,000	Conveyor (silage)	200
		Grain distributor (over parlor)	300
Equipment Sub Total	$12,500	Equipment Sub Total	$ 8,000
Total Added Investment	$41,000	Total Added Investment	$33,000
Annual Costs:			
Structures (10%)	$ 2,850		$ 2,500
Equipment (20%)	2,500		1,600
Annual Fixed Costs	$ 5,350		$ 4,100

Remember . . .

"Dollars and cents" economics will always play a vital part in any decision about the physical reorganization of farmstead facilities, but other factors, also of great importance, must be seriously considered.

A reorganization plan which cuts the time required to do routine work will result in a saving in production cost. The true value of the time saved, however, cannot always be said to be only the product of hours saved and the unit cost of labor. The speed with which a job can be done, especially during periods of the year when time is particularly valuable, can be of extreme importance.

In another area, the ease of doing chore work not only affects the quality of performance but may well have a critical influence on the quality of workers interested in doing the job. Also, with careful planning, reorganization can result in an expanded operation without the necessity of having to face the prospects of unfavorable competition in the labor market.

Buildings and equipment planned to make chore work less laborious will help to preserve the health of the person doing the work and might allow a worker with physical limitations to perform even "hard" jobs satisfactorily.

Cooperative Extension Service, New York State College of Agriculture at Cornell University and the U. S. Department of Agriculture cooperating. In furtherance of Acts of Congress May 8, June 30, 1914. M. C. Bond, Director of Extension, Ithaca, N.Y.